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Structural propeties of disk galaxies: The intrinsic equatorial ellipticity of bulges

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Abstract.
The structural parameters of a magnitude-limited sample of 148 unbarred S0-Sb galaxies were derived to study the correlations between bulge and disk parameters as well as the probability distribution function (PDF) of the intrinsic equatorial ellipticity of bulges. A new algorithm (GASP2D) was used to perform the bidimensional bulge-disk decomposition of the J-band galaxy images extracted from the archive of the 2MASS survey. The PDF of intrinsic ellipticities was derived from the distribution of the observed ellipticities of the bulges and misalignments between the the bulges and disks. About 80% of the observed bulges are not oblate but triaxial ellipsoids. Their mean axial ratio in the equatorial plane is $\langle B/A \rangle = 0.85$. There is not significant dependence of their PDF on morphology, light concentration or luminosity. This has to be explained by the different scenarios of bulge formation.

1. Structural parameters of the bulges and disks

The structural parameters of the bulges and disks of a magnitude-limited sample of 148 S0-Sb galaxies were derived from 2MASS $J-$band images. We used GASP2D, our new code for two-dimensional photometric decomposition (Méndez-Abreu et al. 2008). The Sérsic bulge and exponential disk were assumed to be characterized by elliptical and concentric isophotes with constant (but possibly different) ellipticity and position angle. We found that the surface-brightness radial profiles of larger bulges are more centrally peaked than those of the smaller bulges. Larger bulges have a lower effective surface brightness and higher absolute luminosities. They reside in larger disks, as revealed by the correlation between central velocity dispersion and disk scalelenght. This reveals a strong coupling between bulges and disks. Larger disks have a lower central surface brightness.

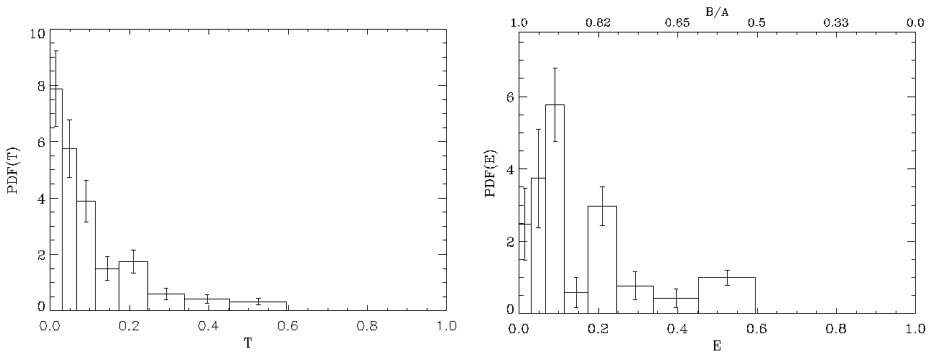

Figure 1. Left panel: PDF of our observable T which is calculated from the twist angle (δ) between the bulge and disk, bulge ellipticity (ϵ) and galaxy inclination (θ). Right panel: PDF of E obtained from the inversion of T. E is related to the intrinsic axis ratio by E=$(1-B/A)/(1+B/A)$ where A and B are the semi-axis of the bulge ellipsoid. The probability is normalized over 10 bins geometrically distributed, the width of the first bin is 0.03 and the width ratio is 1.25. Error bars correspond to a Poisson statistics.

2. The equatorial intrinsic ellipticity of bulges

The determination of the intrinsic shape of bulges is an ill-posed problem, that can be tackled only in a statistical way. A new approach to derive the PDF of intrinsic equatorial ellipticities using only photometric data was used (Méndez-Abreu et al. 2008). Fig. 1 shows the PDF obtained from our galaxy sample. The significant decrease of probability for $E < 0.07$ (or equivalently $B/A < 0.93$) suggests that the shape of bulges is elliptical rather than circular. The average ellipticity $\langle E \rangle = 0.16$ ($\langle B/A \rangle = 0.85$) is in agreement with previous findings by Bertola et al. (1991) and Fathi & Peletier (2003). The PDF(E) is not related to morphology, light concentration, or luminosity of bulges.

3. Discussion and conclusions

The photometric and kinematic parameters of the bulges of our sample galaxies follow the same fundamental and photometric planes of elliptical galaxies, supporting the idea that both are formed in the same way. However, the correlations between the bulge and disk structural parameters are usually interpreted as an indication of secular evolution processes. Therefore, the above relations are not enough to distinguish between bulges formed by early dissipative collapse, merging or secular evolution. All these scenarios could be tested against the PDF of the intrinsic equatorial ellipticity of bulges.

References

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